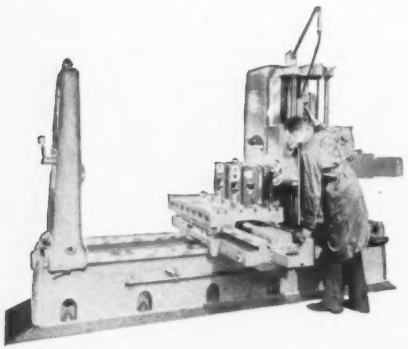
tech
engineering
news

Another page for **YOUR BEARING NOTEBOOK**



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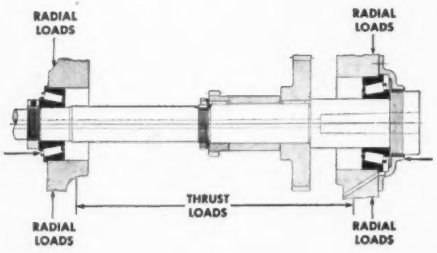

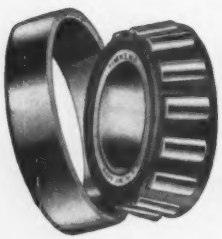

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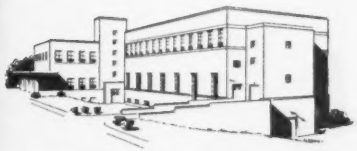
Classroom work is combined with conferences and actual work assignments to help develop potential abilities.

Convenient facilities are provided for formal and informal gatherings at the new Westinghouse Educational Center. Bottom shows the terrace lounge portion of the rumpus room.



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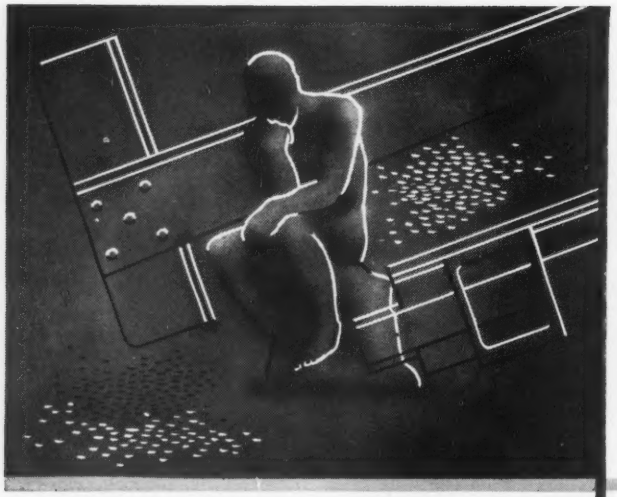

Thinking of improving

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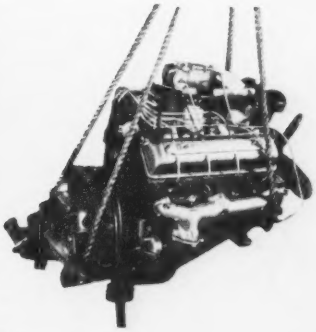
THE DU PONT DIGEST



On the road and in the laboratory, Du Pont scientists are writing

The Inside Story of Engine Deposits

Engineers have long known that deposits which accumulate in gasoline engines have a direct bearing on engine performance. Even now, however, no way has been found to eliminate these deposits or their effects.

As a manufacturer of chemicals used by the petroleum industry, the Du Pont Company has a particular interest in this problem. It is currently the subject of a comprehensive research project, conducted both on the road and in the laboratory.

When Du Pont engineers began their studies, some aspects of the relationships between engine, fuel, lubricant, operating conditions and deposits were known. But to understand how and why deposits form and to develop corrective measures, they needed additional information.

Engineers take to the road

To get these facts, Du Pont engineers are supervising tests in a fleet of passenger cars and trucks that travel hundreds of thousands of miles yearly under carefully controlled conditions. The effects of deposits on octane number requirement, valve performance, spark plug condition and other performance characteristics are measured. After each test, the deposits are weighed and examined physically and chemically.

In the laboratory, other engineers study the effects of the same variables on multicylinder engines. Here, where closer control of the engines is possible, greater attention can be paid to specific fuel or engine operating effects. Performance factors, such as power output, can be more conveniently measured.

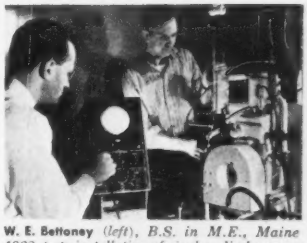
A third group of Du Pont engineers uses single cylinder engines in laboratory studies of deposit formation, adhesion, removal and harm. Exploring new fields, these men had to design complex instrumentation for measuring factors such as surface condition and deposit thickness.

Chemists synthesize deposits

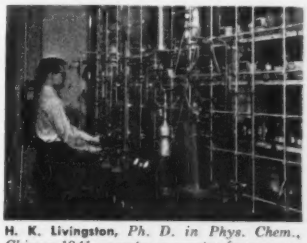
Chemists, too, have an important place in this research. They study the chemical and physical characteristics of engine deposits. Among other things, they devise ways of synthesizing, in fired engines, deposits consisting almost entirely of a single chemical compound in order to study its effect on engine performance.

The results of this comprehensive research program are not yet conclusive, although the relationships between engine, fuel, lubricant, operating condition and deposit formation and harm are much better understood. In the past Du Pont scientists have licked even more difficult problems. Working as a team, they will persist in their effort to provide the motorist with improved engine performance through better fuels.

Douglas L. Schultz *(center), B.S. in M.E., M.I.T. 1947, supervises installation of engine for study of deposit formation in truck operating under heavy-duty conditions.*



W. E. Bettoney *(left), B.S. in M.E., Maine 1939, tests installation of single-cylinder gasoline engine used in study of factors influencing deposit formation in the combustion chamber.*



H. K. Livingston, *Ph. D. in Phys. Chem., Chicago 1941, operates apparatus for measuring porosity and absorptivity of combustion chamber deposits taken from test engines of the Du Pont automobile test fleet.*

DID YOU KNOW . . .

. . . about 60% of Du Pont's sales today consist of products that didn't exist or weren't commercially available 20 years ago.

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tech engineering news

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FRONTISPIECE

— Obviously a city from the air. Recognize it?

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relation between teaching and research

By Dr. Karl T. Compton

The invitation for me to write an article on this subject is presumably stimulated by the very wholesome interest in all aspects of the M. I. T. educational program which has been created by the searching analysis and, in my judgment, the very wise recommendations of the Lewis Committee's Report on Educational Survey. If this report never did another thing than to stimulate this interest on the part of students and faculty alike, the time devoted to its preparation would have been well spent. But it is destined to accomplish far more than that.

What is the objective of our education? There are many answers to this question, as many as there are different kinds of men, of jobs and of opportunities. Few, however, would quarrel with the assertion that the chief end of professional education is to develop the power of taking wise and effective action. This involves powers of analysis and judgment, of ingenuity backed with knowledge, of organization and of initiative. It is not enough to possess knowledge; it is also necessary to have skill in applying it to concrete situations — and these situations generally require discovery of some new knowledge.

A teacher should impart knowledge to his students. Too often, however, this is the end as well as the beginning of the teaching regime. It is the easiest of the teacher's tasks, and it is the least taxing on the student. Too often a teacher is judged by the extent to which the students feel that they have acquired from him a lot of information in an interesting and relatively effortless manner. This is all right as far as it goes, but the result falls far short of the goals described in the preceding paragraph.

With these thoughts in mind, let me outline several incidents and experiences which bear on the question: "Who is a good teacher?"

In the early 1930's, while in the process of becoming acquainted with the M. I. T. alumni, I was telling one of the alumni clubs about the current activities at the Institute, and in the following discussion one of the alumni asked: "What is being done to improve teaching? When I was at the Institute the teaching was lousy!" I asked him to give me an example. He named Professor A. A. Noyes. This was a great surprise to me and I exclaimed: "I have never seen Professor Noyes teach a class; but if you will ask any chemist to name the fifteen leading physical chemists in America, you will find that about twelve of them were A. A. Noyes' pupils at M. I. T. I consider Noyes to be one of the world's greatest teachers." To this the alumnus replied: "I was in his classes for two years, and got nothing out of them."

(Professor Noyes, now deceased, left M. I. T. for California Tech shortly after World War I, largely because that institution was making great plans to incorporate research into its educational program, whereas the attitude at M. I. T., at that time, was that research was a permissible outside activity for a professor, but there was considerable doubt whether it had any legitimate role as part of the educational program.)

Lord Rutherford, who for some three decades led in the pioneering of radioactivity, and was the inspiration and guiding genius of the present generation of atom-smashers, advised his students to avoid the library while they were beginning the study of some new problem. Said he: "Until you have worked on the problem yourself long enough to have some ideas of your own and some basis of critical judgment, the reading of some one else's ideas on the subject will so channel your own ideas into a groove that it will thenceforth be difficult for you to make any original contribution."

Of course Rutherford was not dealing with beginners; he could assume some basic familiarity with at least the basic principles of science. But I am convinced that there is validity in his pedagogical approach even for the younger students, and twice in my career I had a chance to act on this conviction, with gratifying results.

As a teaching fellow at Princeton I had charge of a group of laboratory sections, with an excellent opportunity to evaluate the results of the very systematic regime in that first year physics laboratory. A special manual had been prepared to fit the experiments of the course. Not only were very complete descriptions and explanations given and the apparatus set up ready to work, but even the formulas for the computations were printed, with blank spaces labelled for introduction of the experimental measurements. As a scheme for insuring that the student had access to all the knowledge and could go through the motions in the easiest possible way, it was fine. As a program to develop real understanding, ability and interest, it was decidedly unsuccessful.

When I later went to my first independent teaching position at Reed College, my reaction against the spoon-feeding method led me to the opposite extreme and, unknowingly at that time, to something like Lord Rutherford's method. I locked up in my office all first-year laboratory manuals, and avoided all direction sheets. In their place I designed a set of assignment cards, which simply stated specific goals of laboratory exercises — measurements, exploration of relationships, etc. — without any suggestion of procedure. The first job of the student getting one of these assignments was to plan his own method of doing the job. When he had his plan worked out, he explained it to me and I gave him the equipment which he called for. Only after he had worked with his own device and got results with it, or discovered that his scheme was impractical, would I give him a laboratory manual or other description of the most approved method of achieving the desired experimental result. Thus each assignment was like a little research problem, and a means of developing the power to meet new situations; and when the finer points of the most approved laboratory methods were later studied and followed, it was with some appreciation and understanding.

My second chance to try this method was after my return to the Princeton faculty, where I was asked to put it into effect in a senior elective class in electronics, and here also the results were gratifying.

The difficulty with this method of teaching is that it is very difficult to follow with large classes. Also it is a far more severe tax on the time and ingenuity of the teacher than is the more conventional method of dispensing well digested doses of information. In my own

(*Continued on page 18*)

...and now karoso

By Andrew Browder, '53

Of all the games of skill with which men of the western world have traditionally tried their wits, the two foremost are unquestionably chess and checkers. The former is now far more widely played than many people might believe, and in fact has had more literature published about it in the United States than any other game; the latter, once very popular, is now rarely played to the extent chess is. Among the devotees of both games, there often comes a point where the game seems exhausted of interest, and they turn to other diversions. Thus, the great master Capablanca once issued a statement to the effect that he had completely mastered the game of chess, that there was no more interest in it. Another great master, Emmanuel Lasker, perhaps the greatest chess player who ever lived, made checkers interesting by adding a few new concepts (he called the resulting game lasker). While neither Capablanca nor Lasker stopped playing chess professionally, both of them devoted more and more time to games such as lasker, Wei-Chi (better known by its Japanese name of Go), and Karoso. Incidentally, these three games in recent years have become the especial favorite of scientists and mathematicians. Go today stands much higher in point of number of active players than either lasker or Karoso. It is the latter, however, that seems destined to be the leading strategical game of the future.

Wei-Chi was said to be invented by the Chinese Emperor Shun (2255–2206 B.C.). Other legends attribute it to one U, who invented it for the Emperor Kieh Kwei, about four hundred years later. Whatever its origin, by the tenth century B.C. it was widely known and played, as witnessed by its frequent mention in literature of that period. In the eighth century A.D. Wei-Chi was brought to Japan, where it was called Go, by which name it has come to Europe and America. Go is a game of far more strategic depth than chess, although much simpler to learn. It is the national game of Japan, the only country in which exists a class of professional Go players, who generally earn their living by teaching. In fact, there are nine distinct classes of professional Go masters, the ninth class, now called Honinbo after the first champion, having been attained by only a few players in history. It is said that the finest Occidental players are at best still inferior to masters of the second rank. This game has recently been undergoing a tremendous growth in popularity in America among the relatively small group of players who take such games very seriously. Americans also like to play two minor variants of Go, known as Go Moku, and Ni Nuki.

Players of lasker differ from those of Go and Karoso in that, besides spelling their game with a lower-case letter, they approach the problem of finding new resources in games by modifying an existing game, rather than breaking entirely new ground. Lasker introduces into checker science a conservation of energy principle; that is, pieces captured are not removed from play, but remain as potential forces. There is no space here to go any further into this fascinating game; anyone wishing to learn more concerning the tactics and strategy of this more subtle and exciting mutant of the genus checkers can probably find lasker players at any checker or chess club, including that at M.I.T.

It will be the chief purpose of this article to discuss the origin and development of Karoso, the third important board game after chess and checkers. The father of Karoso was a Polish scientist and man of letters of the late nineteenth century.

When I. Boslevetsky, dean of Krakow chess players and a locally prominent mathematician, weary of the cliches of nineteenth century chess play, turned to the resources of his own mind to form a new and daring experiment in games of skill, he did not choose to elaborate further on the rococo ornateness of traditional chess. He simplified.

Left to right: Eugene Amazon, '52; Andrew Browder, '53; Don Lew, '52; Daniel Matuzewitz, '53; Georges Marcou, '52; Jeremy Connolly, '53; Daniel Queen, '53.

In brief, Boslevetsky first reduced the number of pieces from sixteen on a side to four. He discarded the old differentiation of mobility as a function of the design of the specific piece, the foundation of chess, and substituted newer, more fluid concepts. In the end, he achieved a game in which the object of play had become a subtle regeometrizing of permutations on pieces and squares. This he called Bosspiel.

Theoretically, it seemed at first that the game could be mathematically formulated by use of the theory of transfinite rings, then undergoing the initial stages of its development. But the computations were of incredible difficulty. After long efforts to crystallize the theory involved, Boslevetsky abandoned the effort, satisfied that it would provide endless problems to the practical player. As it turned out, Karoso's patron saint discovered that Bosspiel, not only imperfectible in the large but too extensive for the human mind to deal with, was not playable.

Thus was born and died Bosspiel, a game played only in one man's imagination, but nevertheless important. For it is Boslevetsky's simplification of this game that we play today as Karoso.

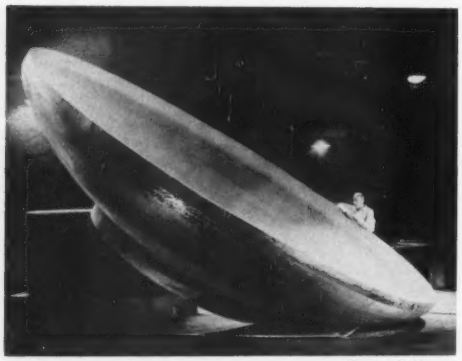
Karoso was scarcely known outside Poland for many years after its invention; in fact, it was not until after the first World War that the game attained a

(*Continued on page 20*)

an age-old art comes to life

By John Mathis, '53

The Pharaohs of ancient Egypt were the first patrons of an art that has recently solved some of the problems of modern industry. The art of metal spinning was probably born on a primitive pottery wheel when an alert ancient craftsman replaced his lump of clay with a piece of gold or copper and found that the



Courtesy, Steelways

A monster spun-metal bowl, actually the top for a petroleum fractionating tower.

rotating metal could also be shaped by pressure, but comparatively little use was made of this discovery until the present great demand for metal products of all shapes and sizes. However, the art of metal spinning has recently left the realm of the past and is now well on the way into the future.

In theory the spinning process is simplicity itself. Just as a potter's hands shape rotating clay around a mold, so the spinner's tools shape a sheet of rotating metal to a corelike form that serves the purpose of a mold. The process is exactly like lathework except that the spinning tool forces the metal to "flow" over the form instead of cutting it to a desired shape. However, the rather simple principle of spinning has only recently been made useable for many industrial applications.

In practice, the metal to be spun is cut into a disc called a "blank" and placed with the desired mold or "form" on a lathe. After the lathe is turning at a certain speed, a craftsman presses against the metal blank with narrow tools resembling sticks in order to force it over the form. Occasionally the metal is heated so that it will flow more easily.

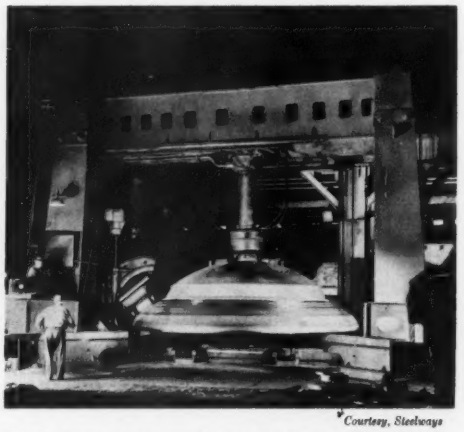
The forms over which the metal is spun are commonly made of one of two materials: laminated maple wood or steel. The hardwood forms, generally used because of the time saving involved in their production, are composed of layers of maple about one and one-half inches thick glued together. Two layers are used even when the thickness of the form is less than that of one because the chances of warping are reduced by the two sections.

If the finished shape is too far from the original form of the blank, one or more intermediate forms may be used to shape the metal gradually. The amount that a metal can be distorted from one form to another depends greatly on its ductility. Aluminum, for example, is so ductile that it can be spun directly from the blank into almost any form, while materials such as stainless steel may require a few intermediate steps in a radical deformation.

The blank is usually simply a circular disc cut from sheets of the metal to be used. If the finished product is somewhat conical, often the developed surface of a cone is cut from the sheet metal. In this case, the seam is welded together to form a conical blank (actually the frustrum of a cone) in the same way that a semicircle of paper can be glued together to form a cone. Obviously this blank will not have to be distorted as much as a plane surface would in many cases.

If the job requires great accuracy or sharp edges, however, a steel form must be used because of the natural yielding of wood to pressures. When one portion of the finished product must be made more accurately than the remainder, the form is often largely wooden with metal portions where greater accuracy is needed.

The major consideration of the actual spinning process is the turning speed of the lathe, since this is the only factor that the spinner is allowed to vary at will. While the product's thickness and material influence the value of the best speed, by far the most important factor is its diameter. Since the size of spun products can vary over a wide range, from tiny electrodes the size of a thimble to giant discs up to sixteen feet in diameter, the turning speed varies correspondingly from about 4,000 rpm. to only 100 rpm. The thickness of the metal to be spun, commonly ranging from one-eighth to about one-half inch, varies the turning speed to a much lesser degree than the size



Courtesy, Steelways

Really large pieces are formed on large machines. This was once a flat disc of steel.

(*Continued on page 22*)

welding progress

Stronger Joints by the Use of Helium

By Edward Becht, '51

One of the images characterizing our modern industrial age is the picture of the electric welder and his fiery arc. Thirty years ago this was not so. Then we would have visualized the riveter jamming red hot rivets into steel plates.

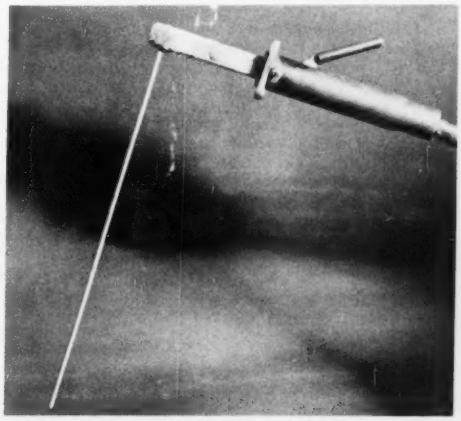
The reasons for this evolution are fairly simple. A welded joint requires less labor than a riveted one; the expenditure of material in a welded joint is far less than in an equivalent riveted structure. Perhaps most important of all, a welded joint is homogenous and not subject to uneven stress concentration. Indeed, *Arc Welding* would seem superior to riveting both economically and structurally.

The process of arc welding has been known almost as long as the electric light. It does then seem rather strange that only recently arc welding has become as common as the apparently less satisfactory operation of riveting as a means of fabrication. One wonders why industry remains faithful so long to the old riveting process when welding is so superior.

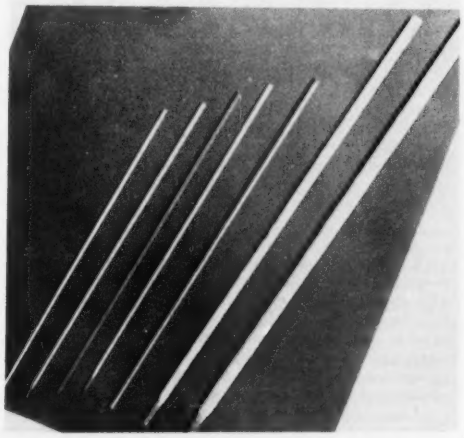
The answer is that welded joints have not always fulfilled theoretical expectations. Too many times welds failed in applications where riveted joints could be wholly trusted. The ideal welded joint was indeed better than a riveted joint, but in service where the true advantages are evaluated, the welded joint fell down because of its unpredictable physical properties. It was the unsolved problem of producing uniform predictable properties that prevented the early use of arc welding in large scale industrial fabrication processes.

Fortunately there were those who were not willing to relegate arc welding to special purpose jobbing. A great deal of research has been carried on in the past few decades and as a result arc welding has become a highly developed and useful process, slowly replacing riveting on almost every job.

Perhaps the most significant problem brought to light by this experimentation was that of oxide inclusion. In arc welding, the surfaces to be joined are fused by means of an electric arc generated between a metal filler rod and the work. During the transference of the metal from the rod to the work, oxidation proceeds at a rapid rate because of the high temperature in the arc. The result is the formation of deleterious oxide inclusions throughout the weld. The consequent inhomogenity of the final weld reduces the strength and ductility of the joint seriously.



A typical welding set-up.



Modern industrial welding rods. The different sizes are for different currents and voltages.

Once the general problem of oxidation in the weld was isolated from other problems, experimenters were able to devise general remedies. The most apparent oxidation preventative is the removal of oxygen from the weld zone. This was accomplished by the provision of a protective inert atmosphere around the weld. In modern metal arc welding, this atmosphere is obtained as a combustion product of a cellulose type coating on the metal rod itself. Sometimes slag-formers, titanium oxide, calcium fluoride or calcium carbonate are added to this coating, to protect the cooling metal deposits from the air. These modifications of welding technique have, to a great extent, removed the danger of atmospheric oxidation.

Unfortunately, the atmosphere is not the only source of oxygen in the welding process. Welding rods themselves contain appreciable amounts of oxygen, often enough to cause inclusions in the final joint. While it is undoubtably true that the major oxidation and gas inclusion difficulties have been remedied by the use of coated rods, there are still some high quality applica-

(*Continued on page 24*)

some elective courses

By the Staff

Below we offer a list of selected possible electives which can be taken this term, with the exception of E37. The opinions expressed are those of individuals who have taken the courses; these individuals will remain anonymous.

If you think that a course critique is useful and should be continued, write us so, won't you?

E37 Public Speaking

The thing which stands out about the public speaking course is the friendly spirit in class. The class is relatively small, and the speeches are often concerned with the personal life of the speaker, so it isn't long before everyone is acquainted. The atmosphere of competition which usually prevails in Tech classes is thus absent, so it's possible to give your speeches to a relaxed group. That is really essential to the inexperienced speaker — to have the audience on his side.

Formally, the course teaches the theory of speaking, private and public. This theory centers around correct diction, organization of ideas, and platform manner. But the practice you get on the platform before a group is the meat of the course. The only trouble here is that one rarely gets to do actual public speaking for a total of more than one-half hour during a term.

Another objection is that there is little attention given to regional differences in pronunciation. An invaluable aid would be a wire recorder to mirror one's speech faults. But this sort of training is currently left to E38, the subsequent course, which incidentally is the only one available this term.

At this point you ask: why take public speaking anyway? To which we reply that every engineer will often have to explain his ideas to assembled wheels. Moreover, if you get to be a wheel yourself, you will begin to think that the assembled public wants to hear what you have to say, so it is wise to become adept at that ancient art of after-dinner speaking.

3.11 Engineering Metals

If you happen to be scouting around in the M. I. T. Catalogue sometime, looking for a good course to fill up that gap in your schedule, you might stop for a moment when you see the number 3.11, and fumble around in the back of your mind to see if you have room for a little knowledge of Metallurgy. If that empty space is there, there's no better way to fill it up than to take a whack at 3.11, which, incidentally, is also called Engineering Metals, if you happen to be sick and tired of numbers.

Engineering Metals is a nine-hour course, of which two are spent in a lecture hall filled with the voice of Professor John Wulff, who, incidentally, is in charge of the subject. Two are devoted to recitations, and one or two more are put in at Building 35, in the Metallurgy Lab, where you will make castings, look through microscopes, and watch various machines tearing bars of metal apart. You will be expected to read the special text and work a few problems at home to fill out the remaining hours.

The subject itself covers metals and alloys; how these metals and alloys are made, and what they are good for. The lab is carefully planned to demonstrate what the instructors say so that there's no chance of their pulling the wool over your eyes. The book, which integrates the whole course, has been written for 3.11 and is sold by the department at cost. And, in case you're interested, the quiz program calls for about three-hour sessions during the term, and no final.

Of Professor Wulff a great deal might be written, for he is well-known in the world of metals. But as far as he is concerned with Engineering Metals, he is simply the man who has made the course one of the most efficient and smoothly running ones in the Institute. Perhaps this is because he has spent a good deal of time studying the psychology of teaching. But in any event, he puts real meaning into a valuable subject, and comes up offering you a not-too-difficult, and well-worth-while nine hours a week.

2.851 Machine Tool Lab

Any engineer with experience in the field will tell you that it's a big stumbling block to doing a good job to be the enemy of the mechanics in the shop. And that is exactly what you will be if you unload on them impractical designs to be fashioned by unobtainable tools from unworkable materials. You therefore should make an effort sometime to consider the available means for making parts. Solution? Take 2.851.

Actually the biggest recommendation for the course is that it is fun for anyone with a bent for making things. Just go and look at the lab sometime; it's in 3-340. Crammed full of machine tools of every kind, all of which you use if you take the course. Lathes, grinders, milling machines, shapers, gear cutters and the like. Actually about eighty per cent of the time is spent on the lathe — the basic tool — which one uses to turn, cut, and bore, perhaps oneself, but theoretically the work. Grading is unique among courses in that the micrometer is god. Make it accurately and you've got an H.

It takes three hours per week in the lab and one in lecture; you'll wish there were more. Don't imagine its the kind of thing which would be given at a mechanic's training school. 2.851 is broad in scope and advanced in treatment. The object is to give awareness of what can be done by mechanics, not to train you to be one. Any engineer who will have contact with machines will find it useful, as well as those who are in experimental research. Plenty of crucial experiments were made possible by a clever gadget.

8.15 Photography

8.15 is a photography course for the amateur whose primary aim is to learn to take better pictures as well as a course for the man who is seeking the underlying science and theory of photography. Professor Hardy expects one to supplement the two hours of class per week with outside reading on any phase of the subject in which his knowledge appears deficient. To any true photographer this is quite painless.

Class hours are from five to six or seven on a weekday evening convenient to the class. These unusual hours separate those who are really interested from those who are just out for kicks.

(*Continued on page 26*)

university patent policy

By Bert Krauss, '54

The first question that comes to mind when considering a university patent policy is, is it necessary? It is obviously desirable to exercise as little control of research as possible; therefore any restrictions should only be imposed if they are really essential. Experience has shown that a policy is essential, not only for the benefit of the university but for the benefit of the public and the invention itself.

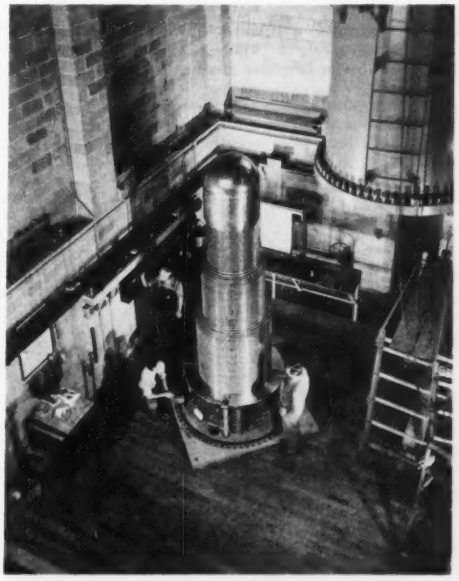
Before 1930 universities were content to let staff members and students handle their own patents and did not believe that the university had any claim to the patent, although it was developed at university expense and time. Furthermore many scientists thought it unethical to patent or exploit their inventions. The practice was to publish them in a scientific paper and thus make them available to everyone. Strangely enough this often defeated the very purpose of the scientist. Marketable inventions were either forgotten or ignored. The inventors failed to realize that a manufacturer wants protection before he will invest the necessary capital to manufacture an article. This protection can be obtained only through patents.

A second fallacy existed in the scientists' belief that it was contrary to the public's benefit to patent his discoveries. By not patenting them he lost all control of their manufacture and development. A disreputable manufacturer could misuse the invention for financial gain. A good illustration of this is the Babcock Process which is used for the determination of the butterfat content of milk. The inventor, Dr. Babcock of the University of Wisconsin, did not believe in patenting his discovery because he felt that the people were entitled to all the benefits obtained through its use. The effectiveness of the test is dependent on the accuracy of the calibration of the bottles used in it. Manufacturers lost no time in putting uncalibrated glassware on the market with the result that the test was nearly discarded. Had Babcock patented his test he could easily have prevented the uncalibrated bottles from ever being made.

I do not wish to imply by the previous example that universities should go into the business of managing and controlling patents. This could lead to a greater evil than not doing anything at all. If a university adopts a patent policy it must be administered with the utmost discretion and care. An unwise policy or one unwisely administered can have calamitous results. One university which discovered this much to its sorrow was the University of Wisconsin.

In 1924 a process for the conversion of ultra-violet energy into Vitamin D was developed by Dr. Harry Steenbock who was connected with the university. Knowing from previous experience that the university's administrative machinery was incapable of handling patents effectively, the alumni formed a non-profit organization having the name, The Wisconsin Alumni Research Foundation. The purpose of the foundation was to commercialize the Vitamin D patents for the public benefit and to obtain money for research at the University of Wisconsin. A control laboratory was established and several companies were licensed. In five years the patents were paying one hundred dollars per day. The foundation gave the university a total of $325,000 during the lean years of the depression. The results of this enterprise (other than financial) were far from good. The Foundation has been under constant attack by the Department of Justice for practices in the restraint of trade. In 1944 the Steenbock patents were invalidated by a circuit court of appeals, which held that the methods used in commercializing them were against the public interest. The Foundation has further been accused of creating a monopoly which has resulted in division of fields, price fixing, and control of container size, which has resulted in excessive and arbitrarily high prices.

It must be remembered that the Foundation was organized with the best of intentions. The fact that it had such unfavorable results is due partly to the poor policy of the university in having a related organization handle its patents and partly to their unwise management.



The five-million-volt electrostatic generator in the High Voltage Laboratory, Department of Physics at the Massachusetts Institute of Technology. It is used for graduate study and research in investigating the structure of the atomic nucleus.

Although the experience of the University of Wisconsin definitely left its mark on the development of university patent management there were other drawbacks which had to be overcome. One of the principal ones was the hesitation on the part of universities in claiming patents for fear of losing their status as a public institution devoted to the public's benefit. One

(*Continued on page 27*)

"...saves nine"

By Rudolph William Preisendorfer, '52

"I cannot understand it . . . I just cannot. What happened when I was gone? It couldn't have been a power failure . . . the error is in the wrong direction."

Professor Bellwhich ran thin, nervous fingers through the remaining few strands of silver hair on his head. Thick blue clouds of acrid smoke circled about him as he puffed furiously at a moist, ragged cigar stump clamped between his teeth. He was all alone in his laboratory, which had the traditional jumble of dusty heaps of equipment, and disordered piles of enigmatic scientific minutia strewn about the room. The huge electronic clock on the far wall hummed unconcernedly just above the threshold of hearing. A leaky water tap near the glass door which was badly in need of a washing, dripped a methodical tattoo on the back of a greasy frying pan that had remnants of yesterday's fried eggs clinging in rapidly decaying globules about the dirty rim.

"The maddening part of the whole thing," he continued to mumble abstractedly, "is that an integral block is missing . . . one whole, basic unit . . . gone . . . vanished . . . and I cannot account for it. The theory wrong?"

He shuddered at this last thought, and crushed the foul cigar stump into the wastepaper basket and kicked the basket away from him in annoyance so that it rolled away with a silence-shattering clamor. It came to rest against a dull cube about eight feet on an edge, from which snaked enormous cables which trailed their rubbery way through the dusty chaos of the laboratory and out into a small cubby hole in the wall, adjacent to which were several huge double-throw switches.

"Everything happens on routine trips, it is always the routine trip that fouls everything up. Why cannot these things happen on the first run . . . the second, or the third? . . . Arrrgh."

He crumpled the square white sheet of notebook paper in his hands and threw it toward the trail of litter that marked the course of the abused wastepaper basket. And in mounting fury, that reached chain-reaction magnitude, he began to sweep his desk furiously with his hands, throwing papers about, causing small desk instruments to take painful trips to the stony floor, splattered his desk with Tunis Blue ink which dripped to the floor in a dark stream and made an azure splatter pattern on the tiles, and then commenced to course methodically through the hexagonal cracks in ever-widening patterns. He didn't notice. His fury mounted higher and higher, and he tracked the ink about the room in four-foot strides, back and forth, back and forth. The last few brave silver strands on his sweating, indoor-paled skull gave up the struggle with his plucking fingers and reluctantly entwined themselves about his fingers and fluttered in wispy, silver strands to the floor. Every few seconds he stopped his shuffling shuttling, and as he did so, he stopped breathing and listened for the almost inaudible hum which came from the unconcerned timepiece, and then, with renewed fury, he started his frantic pacing back and forth again.

Suddenly he stopped, turned, and headed back to the paper-strewn desk, settled himself with controlled deliberation into the leather swivel chair, and extracted a clean, white leaf from his notebook, uncapped his pen, and began carefully to start his calculations again . . . for the tenth time since his return. With each string of symbols, he paused, mumbled to himself and stared up from his work with abstraction-glazed eyes, lips working silently, and nervous fingers toying with the pen, and then with a nod and just the ghost of a frown upon his mouth, he continued placing the symbols down again, finished this set, and the entire ritual started again. At the third page, he lighted a fresh cigar, and once again his body was engulfed in a blue mantle of bitter smoke which issued from the nervously puffed cigar. At the sixth page, halfway down, he stopped, the pen dropped from his nervous clutch, the already ragged cigar fell from his mouth and dropped to the page of calculations amidst a powdery mound of ashes and lay there smouldering with a small patch of crisping, browning paper creeping outward from it.

His fingers clenched and unclenched, and his thin body started quivering, and the tremor grew and became more violent, his lips started to tremble, and then with a violence that belied the apparent strength of his small body, he rose from his chair, picked up the plastic desk and heaved it so that it fairly flew across the room and shattered with crushing force against the door. The door gave, and the glass panel which made up most of it shattered outward into the hall with a kaleidoscopic brilliance, and settled with a tinkling symphony through-

out the entire corridor. One huge shard miraculously unharmed, skittered to a halt down the hall, and bared a fragmentary message to the glowing fluorescents in the ceiling of the corridor, and it spelled:

IC TEMPORAL RESE

LWHICH DR. BAIR A

OOM 2-345 PLEASE KN

Professor Bellwhich deliberately calmed himself. He resettled himself in his chair and turned off the desk lamp that lay on the floor staring upwards with all of its two hundred and fifty watts brilliance. He continued to sit and stare out of the window before which his desk had stood. The campus began to define itself in the early morning light. It was almost light already, and traffic was represented by a few lonely freight trucks out on the drive, everything was very quiet. The awakening elms were mantled in bright yellow buds, and the grass filled the morning air with fresh green smells, unlocked by the glistening dew.

Professor Bellwhich continued to sit and ponder this problem of his, and at regular intervals he would look up at the chronometer and shake his head sadly, his lips would move but no words would come. And at times his eyes would glaze dreamily and he would be repic-

turing the ten completely identical results from his ten nightmarish calculations, and then, with a start, his eyes would focus and see that the campus was a bit brighter, and the shadows would be stronger, and the golden morning light of the new day would be sharper over the still campus. He was completely calm now, and his right shoulder throbbed quietly from the violent effort of an hour ago of throwing his desk into the door. He was very quiet and very still, but every once in a while his head would shake slowly back and forth and strangling noises of puzzlement would rumble deeply in his throat, followed by a long, trembling sigh.

He was now very quiet and calm, and the silence of the room folded softly about him. He had given up the struggle with the problem, it was unsolvable at the moment. He was very tired. His head nodded gently lower and lower on his breast, and the ashy smudges on his vest lifted and quietly fell with his breathing. Professor Bellwhich was asleep.

There was a cheerful, quiet whistling in the hall, and footsteps were approaching the ragged doorway of the professor's laboratory. The steps faltered and stopped, and so did the whistling. Then the steps started again,

and shards of glass chirrupped musically beneath the feet of the approaching stranger. The form of a young man appeared in the ragged frame, and a gasp of amazement escaped his lips as he surveyed the littered floor and the displaced desk, and then the Professor's quiet form in the chair.

"Professor Bellwhich!" The cry came loudly in quiet hall. The young man tried to open the door, but the desk was in the way. He climbed gingerly through the ragged opening and ran to the side of the sleeping figure.

"Professor Bellwhich!"

The old man in the chair stirred and mumbled. The newcomer shook his shoulder gently, and the Professor stirred, opened his eyes and then grew aware of the young man. His eyes focused out of their sleepiness, and found the face of the man.

"Good morning, Bair," he said with weary tones. His eyes rolled automatically toward the huge chronometer on the wall, and a thin shudder coursed through his body; his eyes fell to the streaked and smudgy floor, and rested on the pattern, seeing it for the first time.

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tech engineering news

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from the editor's notebook

I overheard one of my friends chuckling smugly to himself the other day. It seems that he had just been thinking of good old Basil, a high school acquaintance of his, who is up at Harvard now. In my friend's nimble brain a picture of the future loomed quite distinctly. "Poor Basil," he gloated, "ruined. Why what will he have when he graduates besides a sheepskin and some culture? Not a thing! He'll have no background for useful employment like me. There are dozens upon dozens of high-salaried positions that I'll be able to step right into. But Basil — he has no trade, no skills, just a liberal education. About all he'll be able to do is teach. Poor Basil."

I automatically nodded my head in approval, for several years ago I had decided that M. I. T. had it all over Harvard when it came to educating men. However, I didn't feel quite so sure now. What is an education? What should I expect a college to do for me? Not so easy to sum up, I thought. Probably varies from individual to individual. Here's how I feel.

Above all I want a college to teach me to enjoy life through the appreciation of the finer things of life. Principles of electrical engineering and the flow of heat through steel don't seem nearly as important as literature and/or music appreciation by this definition. The man who can relax and be carried away by music, who can feel the beauty of the works of others, and who can at times live emotionally, is far happier than he who lives only for his machines or for his data. Does science tell me how to live happier? Not nearly as well as a few pages of Philip Wylie.

My friend tells me that all this sounds fine in words but that actually it isn't so. Education is the absorption of "higher learning" to him and by the use of his added knowledge and superior ability to originate solutions to problems he feels he will be of value to industry and science. I ask if he will be of value to himself. "Eight hours a day," he continues, "must be spent on a job and education should teach me to be proficient during those hours. My leisure time is the time for the cultural life you're speaking of. Professional attainment above all else, I say."

If you think you can lead a double life — one personality at your work and another at leisure — you are kidding yourself. Being alive and happy is a twenty-four-hour-a-day proposition and not something you can turn on and off at will.

Professional attainment above all else? With that end in mind, my friend, you'll probably get your high-paying job, but if you lose your soul in procuring it, what profiteth you?

See you at Harvard next term.

BOB DONOVAN.

Letter to the Editor...

December 1, 1950

Sir:

I read with interest Mr. Redick's article, *Giant Brains* in the November number. On the whole it was very clear, but I am somewhat bewildered by the first paragraph, which identifies the mental evolution of man with that of Giant Brains. The meaning of that paragraph hinges on the meaning of the term "mental evolution." I take it that he means the evolution of intelligence, but if this is so, Mr. Redick has made several statements which are open to great doubt.

Would Mr. Redick care to define this term so that I and perhaps others may understand his point of view?

JOEL EKSTROM, '52.

(*Continued on page 20*)

THIS IS MODERN

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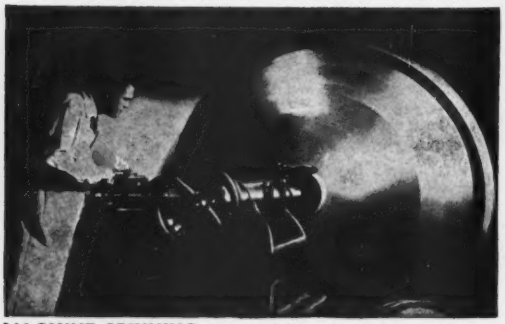

MACHINE SPINNING is essential on large forms, to exert pressures up to 10,000 lbs. Hydraulic tool is shown above by Teiner craftsman, spinning 6 ft. parabolic reflector.

BIG — BUT NOT THE BIGGEST Teiner jobs are these bell mouths, and reflector. At Teiner, "king-sized" blanks up to 16 ft. are regularly available.

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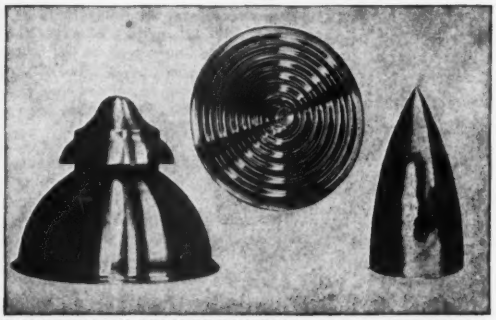

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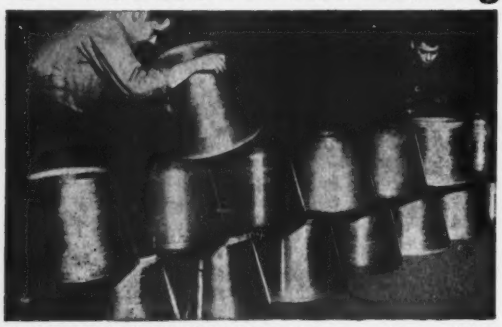
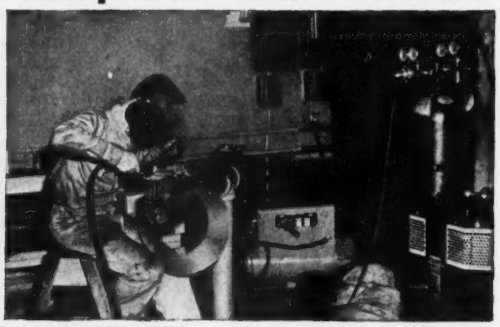


FULL-SCALE PRODUCTION facilities are also available, however, for those products which are best produced by spinning; and against the times when projected short run must suddenly become large-scale deliveries.



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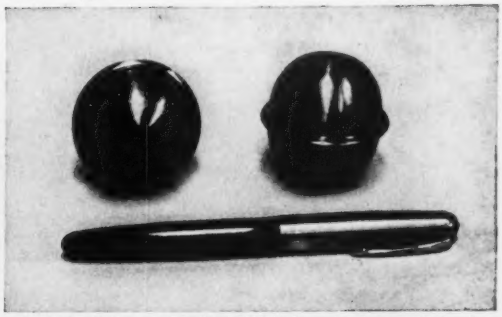
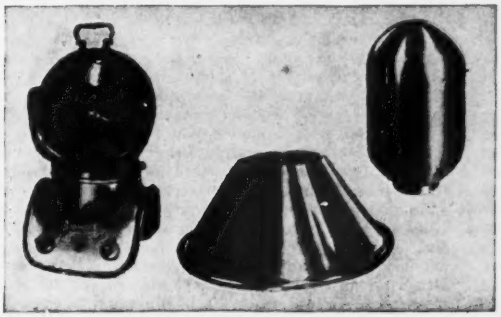


ONLY YEARS OF EXPERIENCE in spinning and development of new techniques can produce work as precise as the miniature floats pictured here.

or spherical section...or any combination



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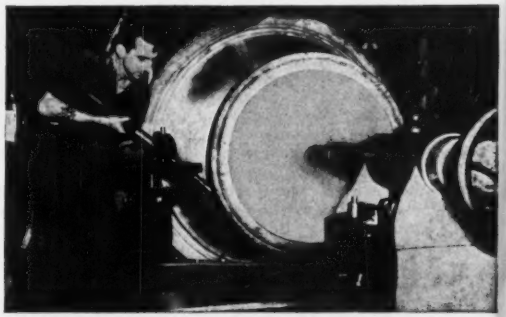

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relation between teaching and research

(*Continued from page 6*)

case, for example, every summer vacation was devoted to the job of developing a list of projects which could be suggested for research problems. These were of varying degrees of difficulty, some appropriate for undergraduate laboratories or theses and some suitable for postgraduate students.

To the extent that it can be incorporated in a teaching program, this method pays big educational dividends; it helps to develop the qualities of judgment, ingenuity, organization and initiative which I mentioned above — and it develops interest on the part of the student. I suspect that most students get bored with their successive months and years of packing away the information of the ages, but I have never yet seen a student who was not excited by the realization that he was actually making some contribution of his own, and whose general interest as a scholar was not thereby stimulated.

I once saw the application of this educational policy, *in reverse*, in the postgraduate department of a great university, where this department had notably failed to achieve the distinction that its facilities and environment should have made possible. I had been called in to try to diagnose the difficulty. An examination of the situation disclosed the fact that the graduate students had not been permitted to undertake research until they had passed the first part of their doctoral examinations, which was usually after two years of postgraduate study. The department's argument for this rule was that it avoided the distraction from his studies which was likely to occur if the student became too much interested in his research work.

This rule seemed to me to be exactly wrong. The students were missing the stimulation to imagination and interest which comes with any attempt to explore the unknown. Some alternation between study and research provides a relaxation from too stiff a dose of either. Finally the quality of the research done by the students under this rule was generally inferior. Graduate students generally count on getting their doctor's degrees in three full years of postgraduate work. Many of them are planning soon to get married, and many of them cannot face the financial drain of still further graduate work. The result of all such factors, under this rule, was that the students selected thesis problems which could most certainly be carried through to completion within one year. This usually meant some problem of minor significance, whose end could be pretty well predicted from the beginning.

From these comments it is probably evident that I am a strong believer in any educational procedure which can spark the creative impulse in a student — and research geared to his capacity is one of these methods. It is not the only method, however. Painting, design in architecture, composition in music are also creative and, in their fields, play somewhat the same educational role as research in science or research and design in engineering. But let us go on to consider several other aspects of the role of research in an institution like M. I. T.

In the first place, though perhaps not bearing directly on the subject of this discussion, is the fact that the M. I. T. charter specifies that the institution is established for the purpose of advancing science and its practical applications, as well as for operating a school of industrial science. But without pressing the legal sanction, the argument for research is justified in a school of our type by its contributions to the educational program. Let me mention very briefly several additional considerations.

An effective technological institution must look to the future rather than to the past. The only way to maintain this attitude effectively is by participating in the creation of the future. Only thus can the staff, the contacts and the facilities be secured.

The consideration of contacts is important in many ways, one of which is of particular value to the students. Our major industries are now pretty well organized to train their own personnel in the techniques of their present production operations. They know from experience, however, that products and production methods are continually evolving to meet new needs and opportunities. The future of the companies depends on their being alert and effective in this continuing evolution. This creates a demand for research and development talent, and the discovery and development of such talent therefore becomes one of the important elements in any educational program in the higher phases of technology.

Finally, there is a very important educational program which is at the other end of the scale from the undergraduate, and even beyond the graduate student. I refer to the young person who may already have demonstrated his capacity for research, who may already have secured his doctor's degree, and who is continuing his research work as a research assistant, research associate, National Research Fellow, or junior staff member. It is in this stage that most of the research men who are destined to become really prominent in their fields develop their highest powers and skills and begin to gain professional esteem and opportunity as researchers. Development of such men is an important feature of our educational program, even though they may not have much apparent contact with what we generally refer to as our "student body."

Let me conclude with a brief statement in the interest of proper perspective. I was asked to discuss the subject of the relation between teaching and research. I am glad to do this because I firmly believe that there is an advantageous contribution of research to education at every level, and that educational programs should encourage adequate realization of this advantage. But I would not want to leave the impression that research is the main objective of education, or even its major tool — or that every good teacher must be an expert and enthusiast in research. The college teacher who aroused my interest in physics had never had experience in research, so far as I know. He did have skill in giving his students the thrill of learning. Whenever I answered one of his questions or solved one of his problems or handed in the results of a laboratory experiment, I always got the impression that he was both surprised and delighted that I had succeeded. This was flattering to my ego, and spurred me on.

So I realize full well that there are many ways in which a person can be a great teacher without becoming so through the medium of research. It is fortunate that this is so, for there are many kinds of people and many kinds of jobs for which they are destined. There is also the great area of appreciation as distinct from creation, in which the teaching arts are quite different. Much teaching must of necessity be of "service" type, aimed at giving knowledge of fields related to, but not strictly part of, the students' professional objective.

An educational program must therefore include many angles of approach, and a faculty must be a team with many kinds of special skills and interests. Within

(*Continued on page 20*)

Drill Night

From a point high on the campus, a radar beam searches the sky. Lights burn in classrooms. Khaki replaces tweed and covert for the night as college men assigned to Reserve units study the machines and methods of defense.

Preparedness is the order of the day.

And the Bell System stands prepared. In five busy years, we have added more than 12,500,000 telephones. Many improvements have been made in the quality and speed of service. Our force of highly skilled, experienced men and women has been greatly enlarged—and now numbers more than 600,000.

A nation in a hurry goes by telephone. This country has the best telephone service in the world.

BELL TELEPHONE SYSTEM

Right: Ice-making Tanks
Big Plant at Nampa, Idaho, Makes 500 Tons of Ice a Day with Frick Refrigeration
And quick-freezes 5 tons of fresh foods per hour at another plant, 600 feet away! Five cold storage rooms hold 2500 tons of ice and 85 carloads of frozen foods.
Seven large Frick ammonia compressors carry the cooling load. They were selected for this Terminal Ice and Cold Storage Co. plant by the Associated Refrigerating Engineers, Los Angeles consultants.
You can specify Frick refrigerating, ice-making and air conditioning equipment with confidence.
The Frick Graduate Training Course in Refrigeration and Air Conditioning, Operated over 30 Years, Offers a Career in a Growing Industry.
Frozen Food Storage
FRICK CO
Above: Air View of Plant
Right: 5 of 7 Frick Compressors, Totaling 1600 Horsepower

relation between teaching and research

(*Continued from page 18*)

this program and faculty at M. I. T. research has an important role. I would not argue that the present over-all scale of research at the Institute should be increased. I do believe that continual and imaginative attention should be given to the securing from it of the maximum possible educational benefits.

karoso

(*Continued from page 7*)

following in every important state in Europe, and in the United States and Canada. In the early 1920's, Karoso had a short-lived burst of popularity in the United States, particularly in New York City. Today one might search the major chess clubs in vain to find two people who play Karoso, although he might find many who remember the great Karoso tournaments of 1923 and 1924. These tournaments, great events in the development of the game, were nevertheless financial failures. Since that time, no major international tournaments have been held, and until the years following the second World War, Karoso was in decline. In the past several years, though, more people have been introduced to Karoso than ever before. Returning GI's brought the knowledge back that they had acquired in France, in England, even in Italy — significantly, not in Germany. In 1947 a national tournament was held under the auspices of the Sheridan Square Karoso Club in New York, and the winner, Dave Berk, was declared United States champion. In the past two years, several important universities have founded Karoso clubs, whose ultimate purpose will be to form an intercollegiate Karoso league. Important among these is M. I. T.

Karoso is an easy game to learn, difficult to play well, impossible to truly master. In these respects it, the newest of significant strategic games, is not unlike Go, said to be the oldest. The basic ideas of both games may be quickly picked up by watching, but the strategy of experts seems fantastically deep to the uninitiated.

Karoso is played on a standard sixty-four square checker board, with three uniform, undistinguished pieces, which both players move alternately, usually one at a time. From this description, the total number of positions possible must seem at first to be very small. However, when one realizes that a single square defines nine discrete positions, and that a piece may be moved onto any of these or onto points or lines of intersection, it becomes readily apparent that the opposite is the case. In fact, the number of positions available is about 1600^6, a number large enough so that a Swahili savage wishing to notch it up would require a tally stick reaching from Krakow to the star Θ Centauri, over sixty-five light years away! This number represents the total number of points on the board which a Karoso piece may occupy, 1600, to the power of the number of pieces (each piece may play two roles, called "yerd" and "thortle," so that there are in effect six pieces), an approximation to the permutation of 1600 things taken six at a time. A word about these words, yerd and thortle, as well as the expression, "studge," heard so often in play. These are nonsense words invented by the great English player Cunningham to take the place of the original Polish words, unpronounceable to many English and American players, and having no particular useful meaning other than in relation to the game.

Karoso's extreme flexibility, which makes it more popular with some people than others, is also the obstacle to complete mathematical formulation. While simpler than Bosspiel, the determinants necessary for the evaluation of a position can be solved in a reasonable length of time only with the largest digital computers now in operation, and apparently the commercial value of such a project is not sufficient to induce the owners of such machines to devote them to this high purpose.

from the editor's notebook

(*Continued from page 15*)

About Our Authors . . .

Dr. Compton was extremely gracious in writing for us his views on research in the technical institution, a field in which he has had much positive influence. **Rudy Preisendorfer** herein offers his third science fiction to our readers. His club of S.F. writers, by the way, is making headway in a project to microfilm S.F. publications. **Edward Becht**, a senior in Course III, has been thinking of the inert gas idea for some time: here it is. **Bert Krauss** did a good job of digging into the patent system; you'll see more of him before the year is out. **Andrew Browder** is a sophomore mathematician and is part of an eager group of chess and Karoso players in Baker House. Anyone interested in playing the game should contact him. **John Mathis** continues a long and happy association with us; this article is No. 4 for him.

New television microphone, developed at RCA Laboratories, virtually vanishes when in active use.

Vanishing Microphone lets the stars shine

Now you see it, now you don't! RCA's new "vanishing microphone" is plainly visible when standing alone—but let a television performer stand before it and it seems to disappear.

Called the "Starmaker," this RCA microphone is little larger than a big fountain pen . . . and principles of design based on modern camouflage techniques blend it with an artist's clothing. There's no clumsy "mike" to distract your attention from the artist's performance—and it's also a superbly sensitive instrument.

Through research carried out at RCA Laboratories, the "Starmaker" microphone picks up sound from all directions—hears and transmits every sound the human ear can detect. It's not only small and almost invisible, but it's also one of the most efficient microphones ever devised.

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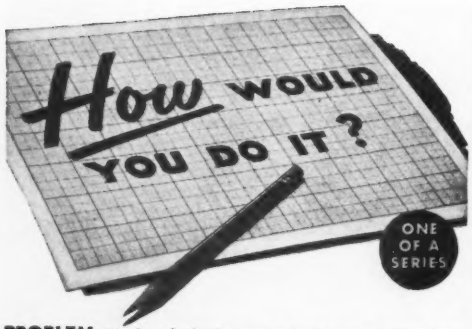

PROBLEM—You're designing a taxi-cab meter. You have worked out the mechanism that clocks waiting time and mileage and totals the charges. Your problem now is to provide a drive for the meter from some operating part of the cab—bearing in mind that the meter must be located where the driver can read it and work the flag. How would you do it?

THE SIMPLE ANSWER—Use an S.S.White power drive flexible shaft. Connect one end to a take-off on the transmission and the other to the meter. It's as simple as that—a single mechanical element that is easy to install and will operate dependably regardless of vibration and tough usage. That's the way a leading taximeter manufacturer does it as shown below.

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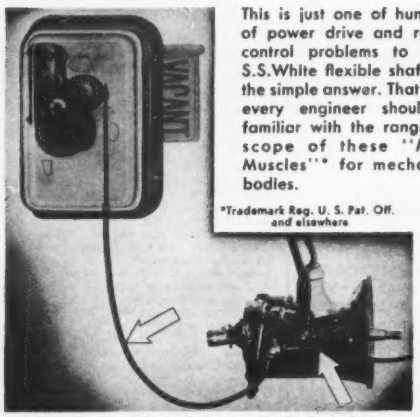


This is just one of hundreds of power drive and remote control problems to which S.S.White flexible shafts are the simple answer. That's why every engineer should be familiar with the range and scope of these "Metal Muscles"* for mechanical bodies.

*Trademark Reg. U. S. Pat. Off. and elsewhere

Photo Courtesy of Pittsburgh Taximeter Co., Pittsburgh, Pa.

WRITE FOR BULLETIN 5008

It gives essential facts and engineering data about flexible shafts and their application. A copy is yours for the asking. Write today.

THE S.S.White INDUSTRIAL DIVISION
DENTAL MFG. CO. Dept. C, 10 East 40th St. NEW YORK 16, N. Y.

an age-old art comes to life

(*Continued from page 8*)

does. The speed is also affected by the class of materials used; ductile metals have a somewhat higher turning speed than stainless steel or special alloys, but within these two classes the actual metal used has little effect. Charts have been prepared that tell the worker at a glance the proper turning speed for a given diameter, thickness, and class of material.

The tools used to press the spinning metal into shape also vary in composition, but the general rule is that a soft tool is used on hard metal and *vice versa*, so that one or the other will shear easily and reduce frictional heat. Blocks of soft birch mounted on hickory handles are used on hard stainless steel, while soft aluminum requires hickory tools with iron tips. Hydraulically operated rollers are being used to take the heavy labor out of spinning thick plates.

Very large forms require more than hickory. The wooden tools first shape the metal roughly. Then a specially built high-carbon steel tool takes over and completes the job. The design of these special custom-made tools for large or heavy products is one of the spinner's biggest jobs.

Big problems such as tools are by no means the only test of the spinner's ingenuity; he faces a hundred small ones daily. A sample: how is the form removed from within a narrow-mouthed container after the metal is spun over it? (Answer: build it in sections like an orange, so one small section can be removed at a time.) Another: some metals cause trouble by springing back a fraction of an inch from the form after spinning. How much smaller than the finished product should the form be in order to compensate for the increased size of the metal? Only an expert can guess how much space to allow, for the distance depends on the material, its thickness, shape, and other characteristics. The estimate is really based on a mixture of experience and intuition.

The quality of the finished work largely depends on the skill of the craftsman. The worker controls his tool by placing it on a rest and putting his weight on it. He must learn by long experience how much pressure to apply, how fast to force the tool across the metal, and how to spread the metal evenly across the surface. The worker must have an inborn manual skill and then

Courtesy, Steelways

The first step: a thin disc is forced over the form.

Courtesy, Steelways

The piece, a part for a guided missile, nears completion.

develop a "feel" for the metal. At the present time there is such a chronic shortage of spinners that a West Coast firm has run advertisements in Boston papers offering such inducements as free golf lessons to spinners willing to move!

The principal reason behind the recent upsurge of the ancient art of spinning is industry's discovery that it can provide parts that are not needed in great numbers much faster and cheaper than stamping can. The only original expense in spinning is the making of a single wooden or metal form, while stamping requires large dies and presses costing thousands of dollars. Therefore a slightly greater cost per article in spinning is often more than offset by the lower installation costs and time savings. Spinning is particularly adapted to producing a few experimental parts that might be subject to change, so one of the industry's main functions is to provide parts for research. Thus the metal products of tomorrow may be found on the spinning lathes of today.

Besides flexibility, spinning has another great virtue: versatility. It is possible to vary the sizes of products from a fraction of an inch to several feet while maintaining accuracies on ordinary products to within about .015" and on specially handled jobs to within .005". Furthermore, a great variety of metals can be handled including virtually all common industrial metals and alloys. Welding can also be used in conjunction with spinning to produce an even greater variety of products. Spinning is also applied to tubing; both expansion and reduction can be accomplished by cold *spinning*, but the use of heat greatly increases the range.

One example of an application of spinning is the production of the large metal cones that are the heart of TV sets. A TV manufacturer got the idea of spinning from a company that was spinning cream separator discs. He soon found out that the nineteen-inch aluminum cones could be spun in one operation, while six separate stamping processes would have been required for the same job. The cones are now produced on an automatic hydraulically operated machine that is capable of spinning a cone every two minutes. In this operation, as well as several others, spinning is able to compete with stamping even on a fairly large number of items.

Spinning benefits us directly in many ways. The lights above a baseball park are spun parabolic reflectors similar to the ones six feet in diameter that are produced for television transmission. Other big customers of the industry are chemical companies wanting round-bottomed reactors and kettles, refineries that need parts for fractionating towers, boiler makers who need seamless boiler heads, and many others.

Probably the spinner's most important customer is the United States Government, for many of the parts for its jet engine and guided missile research program are produced on spinning lathes. Aircraft companies also rely on the spinner's art.

One primary characteristic of the industry today is its strict avoidance of the word "impossible." Five years ago one would have been laughed at if he had predicted many of the things that spinners do to stainless steel today. Whenever engineers and metallurgists said something couldn't be done, spinners immediately set about to prove them wrong. Quite often they succeeded. There are a lot of things they haven't solved yet, but they still keep on trying to make something new with an old method.

Courtesy, Steelways

A clever trick enables one to remove the form from the bottleneck. Note how the form is made in sections like an orange.

welding

(*Continued from page 9*)

tions where welding is unsuitable because of the oxygen in the rod itself.

The very presence of oxygen in the welding rod seems rather peculiar at first glance. Welding engineers have spent years devising ways to remove atmospheric oxygen from the weld area, yet even the most modern welding techniques preclude the use of a rod rich in oxygen. To understand this paradox we must examine the mechanics of the welding process more closely.

It has been postulated that the actual transference of molten metal from the rod to the work is facilitated by the expansion upon heating of entrapped gases within the rod itself. This expansion is said to literally blow the metal across the gap between the filler rod and the work. We definitely know that gas free welding rods are unsatisfactory for ordinary use and of no value whatever for overhead welding. It is therefore reasonable to use only gas impregnated rods for welding. This does not however necessarily imply the use of a high oxygen rod.

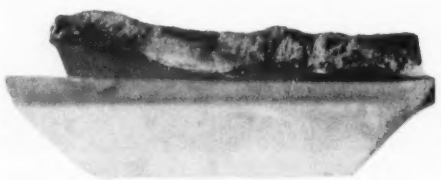
To find the reason for using oxygen rather than a less harmful gas for this expansion process it is necessary to examine the commercial processes for making steel ingots, from which all types of welding rods are made. Steel ingots are divided according to internal structure into *rimming, semi-killed* and *killed* types. Completely deoxidized or *killed* steel solidifies without the formation of gas pockets and has a shrinkage cavity or pipe. *Rimmed steel* contains enough oxygen to evolve carbon monoxide during cooling and solidification; the resultant blow holes are distributed throughout the ingot and the formation of a shrinkage pipe is avoided. *Semi-killed* steel is partially deoxidized and intermediate between *rimmed* and *killed* steel. It is thus apparent that the three kinds of ingots are actually classified according to their oxygen content, and since the only gas-filled steel is the rimmed steel, it has been common practice to use *rimmed* steel for welding rods, despite its high oxygen content.

The possibility of substituting a deoxidized steel filled with bubbles of a neutral gas immediately presents itself. Unfortunately, there has been no experimentation with this possibility hence its advantages are entirely speculative. The idea itself is certainly attractive, for it combines the weldability of the gas-filled steel with the lower inclusion forming tendency of the killed steels.

The selection of a gas to replace the carbon monoxide of the rimmed steel must be done with extreme care for it would be rather ridiculous to use a gas whose corrosive effects would be as deleterious as the oxygen which it is replacing. For that reason we must immediately eliminate all of the halogens, and other corrosive commercial gases from consideration. Most of the organic gases are out of the question because of their tendency to "crack" or disassociate at the temperatures of steelmaking, forming soot inclusions which also lower the quality of the steel. Ammonia, another popular commercial gas, must also be dropped because of a similiar tendency to disassociate into harmful nitrogen at higher temperatures. Hydrogen is worthy of some consideration, but would probably prove difficult to handle in the refinery. In all probability, the most applicable of the commercial gases would be one of the noble gases. Helium, being the cheapest member of this family, should be the first gas with which to start any experimentation.

So far the following facts have been established: (1) included oxides are a source of weld failure; (2) gas bubbles of some sort are necessary to provide an adequate weld; (3) the *rimmed* steel welding rods now in use are a source of extra oxygen. It has been assumed that a deoxidized steel could be used for welding rods should we replace the carbon monoxide of the high oxygen steels with a suitable inert gas, say helium.

The only remaining problem is the actual mechanism of bubbling the helium through the molten steel. A possible suggestion would be the construction of hollow steel balls, which would be filled with helium and placed at the bottom of the ingot molds preparatory to pouring. This process could quite easily be inserted into the conventional steel making flow sheet without any excessive expense. Helium treated ingots could be made from the same tap as the regularly produced *killed* ingots.



End view of broken weld. Note small gas pits and oxide inclusions. The small black globules are slag inclusions caused by poor welding technique.

The overall advantage of this process is that it could make arc welding satisfactory for high precision fabricating work where other, more expensive techniques, primarily riveting, are being used now. This is of course the goal of arc-welding research.

"... saves nine"

(*Continued from page 13*)

The ink had caked, and small crystals glinted bluely in the bright morning sunlight.

"Say, what was going on here last night? Are you all right? What in the world happened? Looks like a cyclone hit this place . . . say . . . nothing went wrong with the trip, did it . . . "

The Professor rose with infinite weariness, dusted his ashy vest, and walked slowly toward the door, pushed aside the obstructing desk, opened the door, paused, and turned toward his assistant.

"No . . . no, nothing went wrong . . . except . . . "

"Except what?" inquired Bair.

"Except that maybe I am going crazy . . . that is all . . . I am going home to sleep . . . sleep . . . I am so tired . . . have the janitor clean this mess up, and you take the day off. I will see you tomorrow . . . maybe."

"Queer old duck," mused Bair. "Oh well," he said as he dialed the janitor's office, "I'll question him tomorrow about all this."

Bair left the laboratory whistling . . . and why not? It was Spring again, a bright Sunday morning on which for the first time in months he wouldn't have to work. Now he and Julia can go on a picnic out to the Cape and enjoy themselves. They wouldn't have to start back too early either, what with that extra hour of Daylight Saving Time that went into effect last night. They had a wonderful time.

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Graduate study may be pursued in Textile Technology, Ceramics, Sanitary Engineering, and in most of the above professional Courses. The Master's and Doctor's degrees are offered in most of these fields.

For information about admission, communicate with the Director of Admissions. The Catalogue for the academic year will be sent free on request.

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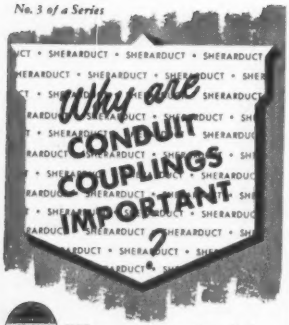
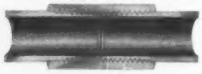
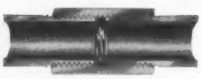


When two lengths of electrical conduit are joined together, ordinarily the point of coupling becomes the weakest part of the run. For this reason the coupling is all-important. And for this reason a Sherardized coupling has special advantages over other types.



SHERARDUCT COUPLING



ORDINARY COUPLING

A Sherardized coupling is galvanized *after* the threads are cut—every thread is zinc protected against rust equally with the outside surface.

The shoulder on Sherarduct couplings is a further safeguard. It covers and protects the final threads so that no raw threads will be exposed to moisture and other corrosive weather conditions.

Sherarduct conduit threads are so cut and couplings so tapped causing conduit to butt, that together they form a practically continuous raceway through which wires may be drawn without difficulty or injury.

Here at the joint, unless perfect continuous grounding is assured as it is with Sherarduct, rust first begins its resistance activity and acts as a barrier.

some elective courses

(*Continued from page 10*)

Professor Hardy is undoubtedly an expert in his field with years of experience. He makes the course worth while for anyone who is willing to put in the time.

M32 Elementary Statistics

Elementary statistics is a mathematics course. You must find out what an integral is before entering it. And you will hear more about that little symbol when you're in it.

Statistics treats of the significance of accumulated numbers. So if you anticipate doing research in a laboratory, or among the consumer public, you will need it to make sense out of arrays of data. And the course, though mathematical, caters to that need, in that Professor Wadsworth, who teaches M32, has experience in the practical applications and points them up to the class.

Statistics is fundamental to theoretical physics, nowadays; if you take 8.07 or a course in wave mechanics, you will find that you are several pages ahead of your fellow brownbaggers. And it is behind such things as cybernetics and the new movement toward electronic problem solution which clothes its dynamic form with such titles as *Whirlwind*.

This sounds pretty terrifying, so it is now time to emphasize the "elementary" part of the course title. The homework is weekly, interesting, and easy. Not many quizzes, though the final is rather tough. This potentially evil situation is rectified by counting the homework as half, which is a pure and simple gift to those who are friendly with the mathematicians in the class and hence are in a position to transpose neatly into their own handwriting.

Be aware, O prospect, that mathematicians *are* in the class. They are required to be by page 77 of the catalogue. Don't tangle with them over integrals, for you will most certainly lose. Confine your efforts to disgrace them to discussions of probability and games of chance. The fact is that no one will carry favorite gambling schemes through the course unscathed. The part of M32 which treats of dice and men will not teach you how to get rich quick, but it may serve to nip in the bud any grandiose schemes you might entertain as a disillusioned engineer at the race tracks.

15.50 Accounting

The course in accounting here at Tech is one of the most basic subjects offered in the field of business administration. While the course, necessarily, involves an element of bookkeeping, the dog work is kept to the absolute minimum necessary to teach the fundamentals. The course aims to deal with the really fundamental questions and to leave the mechanics to take care of themselves.

No attempt is made to establish certain principles or practices as preeminent; rather the various principles are presented merely as such and the student is allowed to decide upon their relative merits. Since accounting practice is a very nebulous thing which depends upon the business facts and their implications in terms of past performance, present position, and future implications, this is a very realistic approach.

The instruction in this course is quite good. Professors Robnett, Beckett, and Hill are all very able and personable teachers as well as practical businessmen. There is the disadvantage that the classes tend to be rather large, and even with the good instruction, this tends to limit discussion.

As a whole this course would be a good one for the non-course XV man who desires a brief but general look into business administration. While the course may not give him the recording technique to enable him to balance his own personal accounts, it cannot help but give him an idea of some of the financial and fiscal problems involved in business.

12.321 Engineering Geology

12.321 is an engineering geology subject designed primarily for civil engineers. It actually is a general information course for anyone who is interested in learning enough fundamental geology to be able to understand what the experts are talking about.

Professor Mead is the lecturer and by his own admission the course is one of the easiest at the Institute. All that he requires is that one write

up his lectures in a notebook after each meeting. This is quite reasonable in light of the fact that it is a 4-4 course, two hours of which are spent in the lab, identifying rocks. This notebook counts about one-third of the final grade. Quizzes are a snap to anyone who listens faithfully to the lectures and writes them up afterwards.

Professor Mead is one of the country's leading geologists and he makes the course worth while. He fails to show up on occasions and the assistant who takes over demonstrates quite effectively how dull and uninspiring a subject it could be without Professor Mead.

The text, Reis and Watson, serves only as a supplement, as no definite assignments are ever made in it. Professor Mead urges strongly that you follow the lectures in the text, but if one is interested only in the grade, it is possible to get an "H" without ever cracking the book.

15.70 Production

15.70 is a course for anyone who plans to do managerial or executive work of any nature. It outlines some of the problems with which all executives are faced and allows one to make his mistakes in the classroom instead of at a conference table. (*Continued on page 32*)

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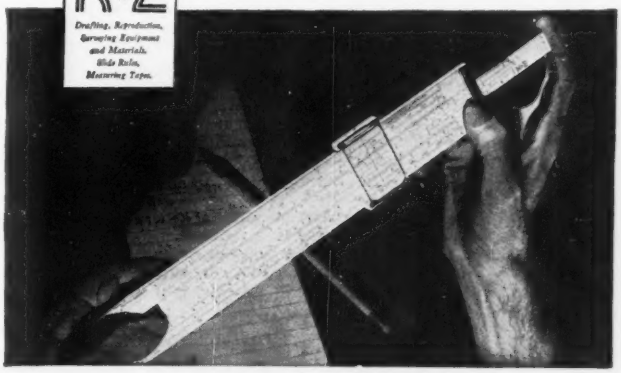

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university patent policy

(*Continued from page 11*)

of the primary "musts" of any public institution is that it have good relations with the public. It was feared with good reason that university-owned patents would meet with public disapproval and might result in the loss of the universities' tax exemption. This danger has been largely eliminated by the organization of Research Corporation in 1912. It was organized by Dr. Cotrell to administer his precipitation patents. It has since blossomed into a foundation for the support of research and the management of university patents. This last function is assuming an ever increasing importance.

The advantages of this type of an organization are considerable. It can handle patent management and patent application with much greater competence than a university because it handles a greater number of patents and therefore has the experience and the skilled personnel necessary for their prosecution. It also removes direct legal responsibility from the university's shoulders, although it will frequently consult it on strategy in legal matters.

Research Corporation handles nearly all M. I. T. patents. In return it receives half of the net amount of the returns, the profits of which it distributes as grants to various research projects. It had given some $1,250,000 to fifty-two universities up to 1948. M. I. T.'s ten-million-volt Van de Graaff Generator was built with the aid of one of these grants.

To illustrate the importance and the functions of Research Corporation I will outline one of the more outstanding cases, that of the Van de Graaff Patents. This case is of particular interest to us because it involves M. I. T. as well as other organizations.

On his arrival at the Institute in 1931 Professor Van de Graaff applied for a patent on his electrostatic generator. A short time afterward he applied for another patent on a system for the generation and long distance transmission of high voltage direct current.

In 1937 a Federal agency showed some interest in the transmission system and it was hoped that it might be commercialized. At this time some difficulty arose as to who had clear title to the patent. Professor Van de Graaff had worked on it at Princeton as a Fellow of the National Research Council before coming to M. I. T. At M. I. T. he had worked under a grant from Research Corporation, but he had conceived the idea for the generator before he had come to Princeton. The National Research Council, Princeton, M. I. T., Research Corporation, and the inventor all had some claim on the patent. A contract was drawn up which provided for the division of income in direct proportion to the contribution of each of the parties.

While the contract was pending, however, a dispute arose over whether or not to give the Government an exclusive license in competition with private industry. As a result the interested agency stopped commercialization and the invention has never had any commercial application.

The development of the high-voltage generator had far better results than that of the transmission system. High voltage X-ray machines were developed at the Institute by Dr. Trump, who was an associate of Van de Graaff's. The patents were turned over to Research Corporation, which found a fairly large number of customers. In spite of this the returns from royalties were almost nil. (*Continued on page 30*)

Giant Lathe . . .

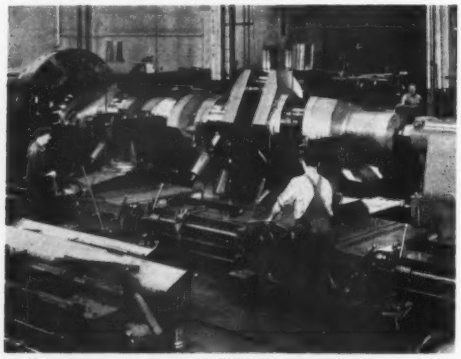
High production of Diesel engines required in the struggle to balance power generation capacity with rising electrical load is bringing new tasks to giant engine lathes.

On the lathe pictured is one-half of a crankshaft for a ten-cylinder Diesel engine. This giant stationary Diesel has a 29-inch bore, 40-inch stroke, and a rating of 7,100 HP.

This five throw crankshaft section on the Mackintosh-Hemphill lathe is a single forging about 23½ feet long and weighing about 22 tons.

The 84-inch by 50-foot lathe is being used for turning the journal bearings and crankshaft cheeks. Lathe carriages are fed longitudinally by a heavy feed screw mounted on the bed between front and middle ways. Carriage cross feed is obtained from a lead screw mounted on front of the bed. A 75 HP motor is used to drive the headstock.

An even larger lathe was turned out during early days of World War II. It was 114 feet long, 8 feet high, weighed 250,000 pounds, and required six gondola cars for shipment from the Mackintosh-Hemphill plant.



New Wind Tunnel Balance . . .

An economical new wind tunnel balance that measures all six basic windage components — three moments and three forces — simultaneously, has been developed by The Glenn L. Martin Company. The project was undertaken with the twin objectives of reducing the expense and the complexity of wind tunnel research.

The M-6-C Balance weighs scarcely three pounds. Cylindrical in form, and less than ten inches long, the device is installed inside the missile or aircraft model to be tested. It is so simply constructed and maintained as to entail but a small fraction of the cost of using elaborate apparatus heretofore required for the purpose. Conventional installations often cost more than two hundred thousand dollars, and call for expensive mechanical servicing.

An exclusive advantage of the M-6-C Balance lies in the fact that the correct values for each of the six components can be read off dials in the control room — directly. There is no longer any need to unscramble the several windage components and isolate them by tedious and costly mathematical computations involving days of delay, even when handled on automatic calculating machines. The data is available at once — during the actual progress of the test.

Rainmaking and Politics . . .

A top weather scientist of the General Electric Research Laboratory sees cloud-seeding and rainmaking as a "hot" political issue of the future. Dr. Bernard Vonnegut, discoverer of the silver iodide method of producing snow and rain from clouds, says strong evidence has been presented that local seeding operations can have nationwide weather effects.

He refers to studies by Dr. Irving Langmuir, consulting scientist of the Research Laboratory, which

briefing

showed a remarkable correlation between regularly-scheduled periodic seedings of relatively-small amounts of silver iodide in local seeding operations in the West and varying weather conditions noted in various parts of the country.

"Obviously, such seeding operations eventually must come under government control, and no matter to what degree such control is eventually perfected, it will not be able to please everybody," he says. "The compromise required to obtain the greatest good for the greatest number will very likely take cloud-seeding into the field of politics, and we may be able to look forward to political speeches charging that one party or the other has hopelessly mismanaged weather control," he says.

New RCA Electronic Computer Aids U. S. Air Defense . . .

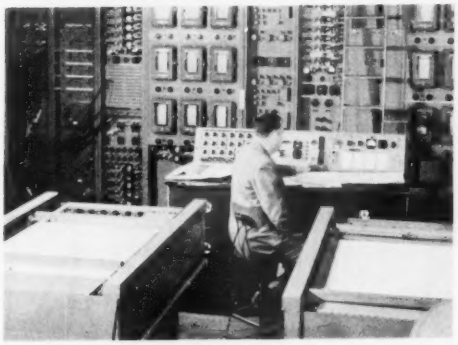
The largest and most accurate electronic analogue computer ever built to evaluate the performance of guided missiles, ships, airplanes, submarines and aid in the air protection of American cities today was shown in operation here publicly for the first time at a joint Navy Special Devices Center-Radio Corporation of America demonstration.

Designated "Project Typhoon," the new electronic computer is expected to save many millions of dollars in the design of guided missiles and also solve many riddles encountered in the air defense of our cities. Complex simulated problems of a complete guided missile system, which other computers are too small or too inaccurate to handle effectively, can be solved by Typhoon. This will enable the design of equipment with a minimum of experiments that would require expensive apparatus, such as missiles, airplanes and ships.

the news

It is expected that the RCA electronic analogue computer will play a significant role in military science of the future. Very often the construction of an experimental guided missile may cost more than one hundred thousand dollars and unless its characteristics are properly checked in advance by accurate computing techniques, actual launchings may be failures resulting in the loss of instruments and apparatus. With "Typhoon" any missile problem can be solved over and over, with the characteristics varied each time until the desired results are obtained. Thus, by avoiding costly trial and error tests, the new computer can, with a high degree of accuracy, assure scientists how a proposed missile will react under actual flight conditions.

The new analogue calculator employs approximately



A. W. Vance of R.C.A. runs the Typhoon computer, some of which is seen in the background. On the plotting boards in the foreground the paths of the guided missile and bomber are traced out as they would occur.

four thousand electron tubes, several miles of intricate wiring and a new set of superaccurate components, exact to better than one part in twenty-five thousand. Under contract with the Special Devices Center of the Office of Naval Research, engineers of RCA Laboratories designed and built the instrument for use by the Navy Bureau of Aeronautics. Three years of research and development work preceded actual construction of the computer.

At the demonstration, the computer was shown solving a simulated air defense problem wherein a high-speed bomber was successfully attacked by a radar-controlled, supersonic rocket-propelled guided missile. The missile was guided with deadly accuracy to the target.

All information necessary to solve the problem was introduced to the machine by means of more than one hundred dials and a portion of six thousand plug-in switchboard connections, mounted on the tall panel sections of the computer. Different dial positions and plug connections represented such characteristics as aerodynamics of the missile, loss of weight due to fuel consumption, and radar signals which follow the missile and target. Other adjustments accounted for the auto-pilot or gyro stabilizers of the missile, the path and velocity of the target, and the main guidance system to be used for directing the missile toward the target in the most effective manner.

An instant after the computer was put into operation by the throwing of a switch at the main control console, electrical impulses flowed through Typhoon's thousands of electron tubes and wires. Within the device, electrical currents and voltages began representing physical things such as distance, velocity and force. Circuits started functioning according to predetermined equations.

While the instrument was engaged in its electronic thinking process, the paths of both the high-speed bomber and the rocket-propelled guided missile were traced respectively by red and green pens on two large plotting boards. From these charts, which provided a permanent record of the test flight, skilled technicians were able to determine the exact position of the missile at any given time.

A three-dimension visual representation of the "dog fight" as it progressed was provided for spectators by an auxiliary device, called the trajectory model, in which two suspended fluorescent balls traveled the identical course of the missile and target. At the same time, a small scale missile model, moved about on a rotating mechanism to simulate performance of the anti-aircraft missile under test. As the model received control signals or instructions from the computer describing how best to hit the target without wasting too much time or fuel, its three sets of fins were deflected as the corresponding fins of a missile would be deflected in actual flight.

While the solution proceeded, twelve recording voltmeters drew curves on paper rolls indicating the positions of the fins, acceleration, velocity, and rate of spin of the missile, as well as the remaining distance between missile and target. Six sets of flashing neon lights on the panels of the computer displayed numbers representing the rates of spin, and the sidewise and forward velocities of the missile.

After only sixty seconds of operation, the computer automatically stopped and the solution was examined. RCA engineers then took the complete answers and explained what factors were right or wrong and how to make changes for better results.

Solution of the problem involved 250 additions, 67 multiplications, 30 integrations, and 20 aerodynamic functions, all carried on simultaneously with continuously variable factors. A mathematician and an assistant would require six months to compute a single solution for the minimum number of points required to give an approximate answer. Typhoon gave the continuous solution, for an infinite number of points, in less than sixty seconds.

It was also pointed out that Typhoon is an extremely versatile instrument. Shortly before the start of the

(*Continued on page 32*)

university patent policy

(*Continued from page 27*)

In the meantime, General Electric had developed an electromagnetic high-voltage generator which could compete with Van de Graaff's for X-ray purposes. In order to speed up the development of the electrostatic generator the High Voltage Engineering Corporation was organized with Dr. Trump and Professor Van de Graaff holding a considerable amount of the stock. All licenses to other companies were recalled and an exclusive license was given to the new corporation for a ten-year period with a non-exclusive license after the ten years expired.

Research Corporation's agreement with the High Voltage Engineering Corporation to handle any future Institute high voltage patents contains several commendable stipulations which are designed to protect the Institute and Research Corporation. They provide for the revocation of the licenses if the High Voltage Corporation participates in any activity branded as illegal by the Attorney General or the Federal Trade Commission or commits any of the following acts:

Illegal tie-in sales or tie-in contracts.

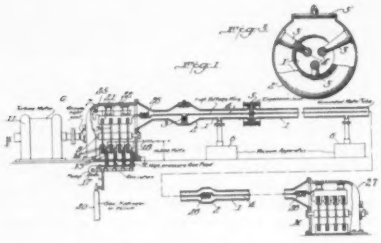
Illegal blacklisting of potential customers.

Combination or agreement with others to fix prices or restrain trade.

Failure to use a licensed process if it is more efficient or less expensive.

Failure to serve a geographical area to the best of its ability.

These provisions, besides protecting Research Corporation and the Institute, assure development or at least an attempt at development of any high voltage patents assigned. This is advantageous to the inventor and the public. Stipulations such as these may be just what is needed to insure the proper handling and development of university patents.



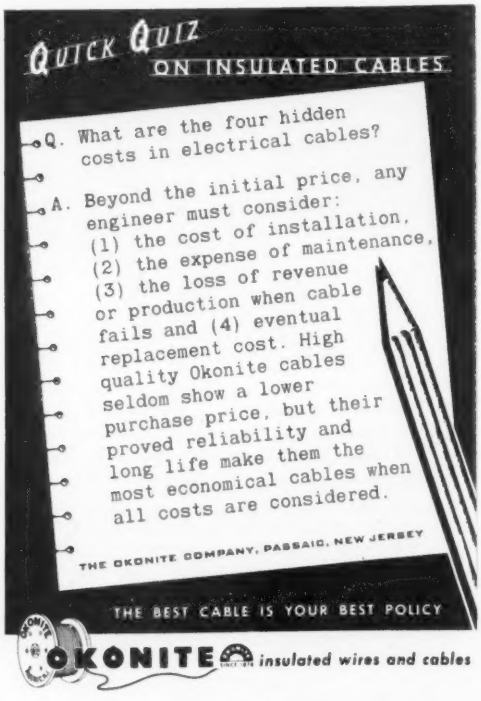
Patent drawing for the Van de Graaff direct-current system. (From U. S. Patent 2,024,957.)

In 1932 with the approval of the Faculty Council the Executive Committee adopted a patent policy for M. I. T. The policy provides for the distribution of the returns in proportion to the contribution of the various parties involved. It follows that a patent which has resulted from an Institute research program and has been financed entirely by the Institute becomes its property. Similarly if the inventor has invented it on his own time and without any substantial financial aid from the Institute it becomes his property. In intermediate cases the profits are divided according to the contribution of each party.

An outside organization which makes a contract with D.I.C. or another Institute agency for research on a specific project, and finances it, receives an exclusive license for ten years for use in its own field of activity. This enables the organization to develop the patent with less risk than it would have to take otherwise, and allows another organization to use the patent in other fields of activity.

The patent problems are handled by two special committees. The M. I. T. Patent Committee determines the inventorship, date of conception and other similar information. It also determines the share of the various parties having a claim to the patent. The Committee on Patent Management deals with the business end of the patent and handles matters affecting public relations and patent policy. Since the policy is a very general one the successful and just handling of patent matters depends largely in these two committees.

It has been the policy of the Institute to place support of the patent procedure on a voluntary basis. This is in keeping with the tradition and purpose of an academic institution. If it were otherwise M. I. T. might as well become an industrial research laboratory, for the freedom of an academic life would be lost to its staff members. It was recently found necessary to require D.I.C. members to sign an agreement obligating them to report and relinquish to the Institute any discoveries made in connection with certain Government contracts. While this agreement was necessary in order to fulfill the contract it would be an unfortunate circumstance if it became a matter of policy to have staff members sign agreements which obligated them in this manner in connection with all research.


QUICK QUIZ
ON INSULATED CABLES
Q. What are the four hidden costs in electrical cables?
A. Beyond the initial price, any engineer must consider: (1) the cost of installation, (2) the expense of maintenance, (3) the loss of revenue or production when cable fails and (4) eventual replacement cost. High quality Okonite cables seldom show a lower purchase price, but their proved reliability and long life make them the most economical cables when all costs are considered.
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THE SMOKE SWELLS . . . the flames roar . . . firemen push into the heart of the conflagration behind a wall of spray. Then almost as if by magic the crackling flames die down . . . the fire is out.

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Sprayed on burning wallboard, wood, even bales of cotton—wetter water penetrates below the burnt outside to the fire beneath . . . puts it out faster with less than one-third of the water usually needed.

Fire departments find that Unox Penetrant reduces fire, smoke and water damage . . . makes the fireman's work safer and more efficient. It is but one example of the hundreds of materials produced by the people of Union Carbide. Among these products there is certainly one or more that will be of value to your business.

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briefing the news

(*Continued from page 29*)

demonstration a complex problem was being solved by the computer. A few hours later, all necessary adjustments had been completed in order to determine the solution for the test problem. On equally short notice, Typhoon may be switched from one problem to another. This feature is a valuable aid to design engineers who require speedy verification of plans before going ahead with construction work.

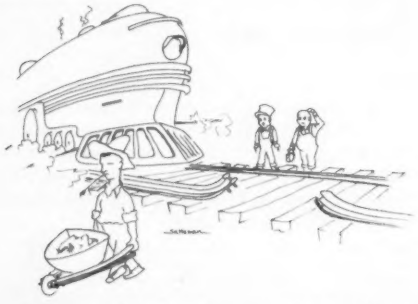
The heart of Typhoon is a new type of electronic multiplier which consists of a hybrid between analogue and digital apparatus. Basically, an analogue device may be compared to the operation of a slide rule, and a digital one is similar in function to an adding machine. By blending these two techniques in more complex forms, Typhoon achieves a combination of flexibility and accuracy unobtainable by either of the systems alone. Each of the more than six hundred electric relays in the computer's multipliers operate in one-ten thousandths of a second.

A staff of nine engineers and mathematicians as well as six technical assistants are required to operate the computer when it is solving complex guided missile problems. To keep the sensitive instrument free of climatic influences, Typhoon is housed in a special air-conditioned room at RCA Laboratories which has a constant temperature of seventy-five degrees Fahrenheit and a relative humidity of not more than fifty per cent.

Old Rails . . .

Transforming old railroad rails into useful products, such as fence posts, bedsteads, clothes poles, wheelbarrow handles and playground equipment, keeps about twenty mills busy in the United States and Canada.

The old rails are not remelted. They are heated to rolling temperature in a furnace and then are sliced into three parts — the head of the rail; the web, namely the middle part of the rail; and the flange or base of the rail. Each of these sections is then rolled to the required size and shape.



Concrete reinforcing bars, structural tubing and light rails are the principal products rolled. Part of the glider on the back porch may once have been a rail carrying streamlined trains.

About seven hundred thousand tons of finished product, mostly bars, are rolled each year from old material such as rails, axles and other products suitable for conversion by hot rolling without remelting. Rails have been used as a source of material for re-rolling since about 1860.

Super Deep-Freeze . . .

A fifteen-cubic-foot refrigerator, believed to be the world's largest very-low-temperature apparatus, which cools its contents to four hundred and fifty-two degrees below zero Fahrenheit and can hold them there indefinitely, is now in operation at M. I. T.

The largest coldest box known, it will open the world of low-temperature research to studies on a scale never before possible.

Technically called a "cryostat," the new machine was designed and built by Dr. Samuel C. Collins, Professor of Mechanical Engineering, in the M. I. T. low-temperature research laboratories with funds provided by the Navy Bureau of Ordnance and Office of Naval Research.

The new low-temperature machine, based largely on principles used by Professor Collins for the construction of a smaller cryostat of original design in 1946, operates by compressing, regeneratively cooling, and then expanding helium gas until a portion of the gas turns into a liquid just seven and one-half degrees above absolute zero, the lowest theoretically possible temperature.

The new machine, Professor Collins points out, fulfills for the first time the need for a large refrigerated space in which heavy equipment can be cooled and studied at lower temperatures than ever before possible. It provides a cylindrical working space thirty inches in diameter and three feet deep — larger than most home refrigerators — in which experiments may be operated and studied while held constantly at this low temperature.

The new cryostat is a tank-like machine which stands more than ten feet high. The refrigerated space is within a cylinder capped, during operation, by a steel lid containing a glass window through which the actual experiments may be observed. Connections to controls and instruments located within the refrigerator itself pass through this lid.

some elective courses

(*Continued from page 27*)

The subject includes almost all of the important topics that can be squeezed into a short eighteen weeks. Briefly, it covers the reasoning behind the proper choice of plant location, buildings, equipment, layout, product design, production planning, and plant organization, and teaches one the techniques of materials handling, materials control, purchasing, quality control, traffic management, and waste control.

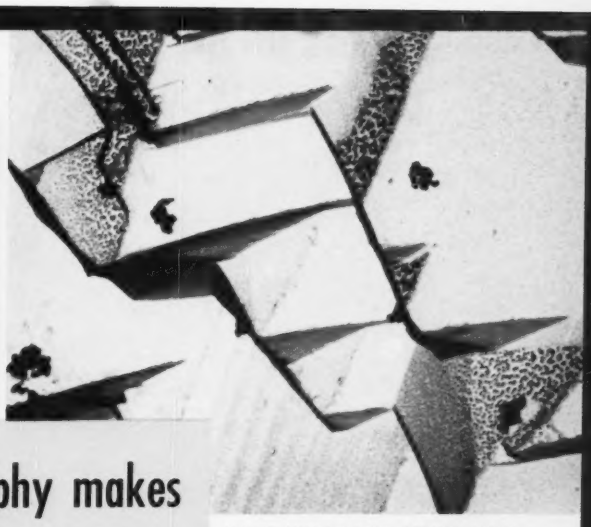
The text is *Industrial Management* by Spriegel and Lansburgh which costs five dollars at the Coop. Supplementary mimeographed notes are distributed in class each week for two extra dollars per term. Reading the notes and text and writing approximately one case report per week constitutes the homework. There are three one-hour quizzes but no final.

To insure up to the minute information outside speakers lecture weekly. Four or five visits are arranged during the term to plants such as the Ford assembly plant in Somerville and the Cote Motor Company in Mattapan. An innovation this term is the weekly showing of industrial movies. These added attractions familiarize one with the techniques of modern industry which is one of the primary objectives of the course.

The instructors are all young men, most of them sensitive to the needs and desires of students. A few are real "live-wires" — enthusiastic about the work, very energetic in their teaching, and tough in their grading. Most are extroverted and love to hear a hearty laugh; classes are very enjoyable.

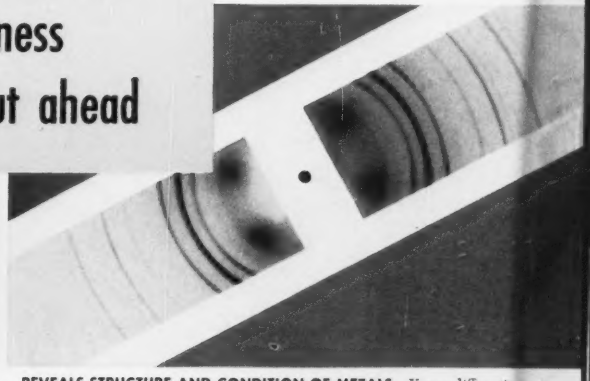
DISPLAYS MASSIVE PRODUCTS—A Diesel locomotive can roar across the Rockies—all on a movie screen in a prospect's office. All because photography can take huge things or small, and make them of a size for a salesman, teacher, or demonstrator to show.

Photography makes big things small—small things big—and business comes out ahead



MAKES MICROSCOPIC DETAILS CLEAR—Photography takes great magnifications produced by the electron microscope (20,000X) on fine-grain Kodak plates, enlarges and records them up to 100,000X on Kodak projection papers. Previously undetectable details and new facts are revealed.

REDUCES FILING SPACE BY 98%—With microfilming, bulky records can be reduced and stored on a few rolls of film. 675 drawings, 24" x 36", can be recorded on a 100' roll of 35mm. Recordak or Kodagraph Micro-File Film. And everything is quickly ready for reference in the Recordak or Kodagraph Film Reader.



REVEALS STRUCTURE AND CONDITION OF METALS—X-ray diffraction patterns on Kodak films or plates provide important information concerning the crystal structure of metals. These patterns help show how alloys can be improved or new alloys made—give data on the effect of machining, drilling, and punching upon the structure of the material.

WITH THE SPEED of a flick of light, photography can reduce or enlarge accurately to scale, and without missing the tiniest detail. And that's not all.

It can magnify time with the high speed motion-picture camera so that the fastest motion can be slowed down for study. It can record the penetrating x-ray and reveal internal conditions of materials and products. With movies and stills, it can repeat a story, time and again, without the loss of a single detail.

Yes, photography serves business and industry in many important and valuable ways. It can work for you, too. If you would like to know how, please feel free to write for literature, or for specific information which could be helpful to you. Eastman Kodak Company, Rochester 4, New York.

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REMOTE-CONTROL WIRING—new low-cost, low-voltage control system lets you turn on lights from many points, or from master switch.
GAS TURBINE locomotive, first in U. S., is now on test with American railroads. It's propelled by power unit similar to that used in aircraft jet engines.

These new G-E developments are creating exciting new opportunities for G-E men

The gas turbine, drawing power from red-hot gases, is being applied by General Electric to the propulsion of locomotives, ships, and planes, and to the generation of electricity. More than 350 G-E engineers, physicists, and other specialists, assigned to this work, are in on the ground floor of a development that promises to revolutionize the production of power.

It's a similar story for the chemists, chemical engineers, and other specialists working today in the development of G-E silicones, and for those who are helping to win a place in the construction industry for General Electric remote-control wiring.

New developments like these, springing from G-E research, are opening up new opportunities at General Electric, and are giving more college graduates the chance of finding exciting, satisfying work.

By placing prime importance on the development of talent and skill, by providing opportunities and incentives for creative minds, General Electric keeps ahead in electrical research, engineering, and manufacturing.

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